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Deep-UV -Lithography: Principles, Optimization, and Simulation

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One of the key issues for lithographic optimization is the definition of metrics needed to classify the process quality. This quality can be improved by the modification of relevant optical parameters, as e.g. the wavelength, the numerical aperture and the coherence of the aerial image. Additionally, the impact of the reaction kinetics of the resist during exposure, post exposure bake and development must be considered in order to exceed the requirements of the device to be fabricated.

An overview of improvement techniques of deep-UV lithography processes will be presented that will gain insight into its fundamental principles required to characterize and to optimize the optical and chemical process. A combination of two different approaches has been investigated, assisted by simulation calculations with the help of the Prolith™ software from KLA-Tencor. In the first approach the focus-exposure matrix is used to determine a process window that leads to a maximized depth of focus for the required specification, as i.e. the target CD, the exposure latitude, the resist loss and/or the side-wall angles. Figure 1 shows the focus-exposure matrix of a hole-array, including the relevant information obtained by a simulation, i.e. the isofocal point, the target CD, the resist bias and the isofocal bias). Secondly, with the help of the gradient-based approach, the gradients of the image that is projected and recorded into the photoresist can be used as a metric for both the achieved image and resist contrast (not shown here).

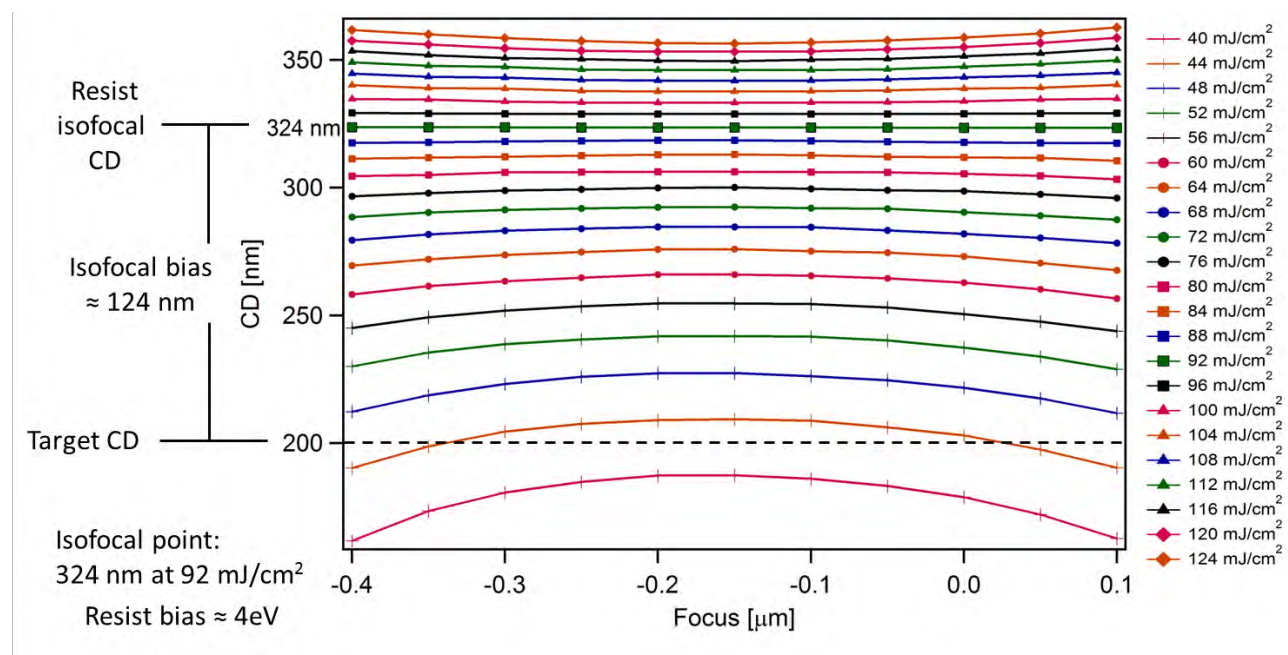


Fig. 1: Focus exposure matrix (Bossung curves) for a hole-array (200nm linewidth, 500nm pitch)